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THE INFLUENCE OF LIVESTOCK MANAGEMENT ON LAND USE COMPETITION BETWEEN DOMESTIC AND WILD UNGULATES: SHEEP AND CHAMOIS Rupicapra pyrenaica parva Cabrera IN THE CANTABRIAN RANGE[1]

S. REBOLLO*, L. ROBLES* y A. GÓMEZ-SAL*

*ABSTRACT.- The spatial distribution and competition for the use of resources between sheep —transhumant merino— and chamois (*Rupicapra pyrenaica parva. *Cabrera, 1910) has been analyzed during the summer grazing period in the Cantabrian range. The studied area, —a 750 ha. wide high pass— was divided into sectors depending on geophysical variables (substratum, aspect and elevation) and vegetation types. Sheep land use was analyzed by direct observation of the flock and by means of enquiries to the shepherd. Chamois were studied before and during the time sheep were present in the pastureland, with the help of fixed itineraries that enabled us to visually cover the whole area. The assessment of land use was carried out by corrected frequency and preference index for each of the studied environmental variables. Sheep grazed in the whole area excepting for beech woods (*Fagus sylvatica*), rocky and steep zones and dense scrub patches. The location of the sheepfolds —shelters, enclosures and associated pastures— is a key factor in the management of the pastoral system. They are usually placed in a central position from where the flock make their every day course, normally directed to higher zones. In the studied area, chamois distribution is limited by the scarcity of zones over 1.800 m., and by the strong sheep grazing pressure at all elevations. Chamois leave the areas grazed by the sheep flock, creating an almost total segregation. They occupy steep rocky slopes and the beech woods edges close to them, both situated furthest away from the sheepfolds.*

*RESUMEN.- Durante el periodo estival de utilización de los pastos de puerto en la Cordillera Cantábrica, se analiza la distribución espacial de las ovejas —merinas trashumantes— y rebecos —*Rupicapra pyrenaica parva. *Cabrera 1910— y su posible competencia en el uso de los recursos. Como referencia se llevó a cabo una sectorización del territorio —750 ha.— según variables geofísicas (sustrato geológico, orientación y altitud) y tipos de vegetación. La utilización de los pastos por las ovejas fue analizada por seguimiento directo del rebaño y mediante encuestas al pastor. Los rebecos*

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* Instituto Pirenaico de Ecología (C.S.I.C.). Apartado 202, 50080-Zaragoza, Spain.

se estudiaron antes y durante la estancia de las ovejas, con itinerarios fijos que permitían cubrir visualmente toda el área de estudio. El uso del territorio se analiza mediante frecuencias corregidas e índices de preferencia para cada uno de los sectores temáticos considerados. Las ovejas pastaron toda el área rechazando tan solo los hayedos, las zonas rocosas de mayor pendiente y las manchas cerradas de matorral. La ubicación de las majadas (refugio nocturno y pastos asociados) es un aspecto clave en el aprovechamiento del puerto. Se sitúan en posición central, desde la que se realizan recorridos —careos— hacia pastos situados normalmente en zonas más altas. La distribución de rebecos se ve limitada por la escasa representación de cotas superiores a 1.800 m. de altitud, así como por la fuerte presión que ejercen las ovejas al pastorear en todos los niveles altitudinales. Durante la estancia estival de las ovejas, los rebecos abandonan las áreas utilizadas por el rebaño, realizándose una segregación espacial casi completa. Se instalan en lugares rocosos con fuerte pendiente y en los bordes de hayedo próximos, localizados en las zonas más alejadas de las majadas.

RÉSUMÉ.- La distribution spatiale des ovins —merinos transhumants— et des chamois —Rupicapra pyrenaica parva (Cabrera, 1910)— et leur concurrence éventuelle pour l'utilisation des ressources, est analysée pendant la période estivale en alpages dans la Chaîne Cantabrique. Comme référence, une sectorisation du territoire —750 ha.— a été realisée, d'après des variables géophysiques (substrat, exposition et altitude) et les types de végétation. L'utilisation des pâturages par les ovins a été analysée par suivi direct du troupeau et au moyen d'enquêtes auprès du berger. Les chamois ont été étudiés avant et pendant le séjour des moutons en alpage, en realisant des itinéraires fixés, qui permittaient de couvrir visuellement la totalité de la zone d'étude. L'usage du territoire est analysé á l'aide de fréquences corrigées et d'indices de préférence pour chacun des secteurs thématiques considerés. Les moutons ont pâturé sur toute la zone, en refusant uniquement les hétraies, les zones rocheuses avec une plus forte pente et les taches de buisson plus dense. La localisation des bergeries (refuge nocturne et pâturages associés) est un point clé dans l'utilisation de l'alpage. Ils se situent dans une position centrale, depuis laquelle sont effectués les parcours vers des pâturages qui se trouvent normalement sur les zones les plus hautes. La distribution des chamois est limitée par la reduite représentation de niveaux d'altitude supérieurs à 1.800 mètres, de même que par la forte pression exercée par les moutons qui pâturent sur tous les niveaux d'altitude. Pendant le séjour estival des moutons, les chamois abandonnent les zones utilisées par le troupeau, d'où une ségrégation spatiale presque complète. Ils s'installent dans les endroits rocheux ayant une plus forte pente, qui se trouvent dans les zones les plus éloignées des bergeries.

Key-words: *Chamois, sheep, competition, land use, pasture management, mountain pastures.*

The study of the interaction between ungulates occupying the same area (BELL, 1971; HUDSON, 1976; SINCLAIR, 1979; HANLEY & HANLEY, 1982; PUTMAN, 1986) shows some interesting peculiarities when dealing with domestic herbivores co-existing with wild herbivores (SCHWARTZ and ELLIS, 1981). Studies into domestic species raised in semi-liberty (KNOWLES & CAMPBELL, 1982; GORDON & ILLIUS, 1989), especially cattle and horses, show that the wild herbivores tend to desert the area used by the domestic species (AUSTIN *et al.*, 1983; SKOVLIN *et al.*, 1983), although there exist a number of cases where

the wild species is favoured (ANDERSON & SCHERZINGER, 1975; WILLMS *et al.*, 1979; GORDON, 1988) or not affected (LONG & IRWIN, 1982; WALLACE & KRAUSMAN, 1987).

There have been fewer studies about domestic herbivores subjected to greater control by man as is the case of sheep raised by shepherding system (PFEFFER & SETTIMO, 1970; COLQUHOUN, 1971; OSBORNE, 1984). They all agree that under this conditions it is difficult to distinguish whether the effects on the wild ungulates are due to the domestic species or to human actions during shepherding (RECHE-RIGON, 1979). Most of these studies analyze the interaction between sheep and species of *Rupicapra* during the summer grazing period, dealing with aspects related with trophic overlapping and habitat use. They show that diet composition is different both in plant species and in the parts of them which are consumed (GARCÍA-GONZÁLEZ & MONTSERRAT, 1986). Wild herbivores avoid the areas used by sheep (BERDUCOU, 1984; GARCÍA-GONZÁLEZ *et al.*, 1990) in a way that is clearly influenced by the topography of the ground (BERDUCOU, 1984). The studied cases had all clear predominance of domestic species and the displacement of wild ungulates was greatly influenced by the presence of the flock itself, the shepherd and the herder dogs (BERDUCOU, 1972).

Even fewer studies have analyzed the shepherding routines and rules (DUBOST, 1981; DUBOST, 1984; BALENT, 1987; GARCÍA-GONZÁLEZ *et al.*, 1990), the elements of the pastoral system that are important in the organization of the domestic herbivores activity (shelter, tracks, etc.) (GÓMEZ-SAL *et al.*, 1991) and the influence of both on the spatial distribution of wild herbivores.

The ecological and cultural importance of extensive pastoral systems are increasingly recognized by ecologist and policy makers in Europe (BIGNAL & MC CRACKEN, 1992). The abandonment of these systems is increasing in mountain areas, and this will be very detrimental of their nature conservation value as they affect fragil habitats and the associated wildlife.

Pastoral systems based on transhumance have a high relevance in Spain and are irreplaceable for the management of wide zones of the Pyrenees and Cantabrian and Iberian ranges (GÓMEZ-SAL & RODRÍGUEZ-PASCUAL, 1992). The use of the pastures in this zones is organized in units of exploitation called "puertos" —high passes—, each one being occupied by a flock —about 1.200 sheep— managed by shepherding system during all summer. The management of this pastures is currently having a process of simplification of cultural traditions on shepherding that lead to the loss of both the structures —built by men or created by animal behavior— and the traditional knowledge which would facilitate the use of the pastures.

The aim of this paper is to analyze both the interaction between sheep and chamois in the mountain pastures and the effects that the management of the flock could have on it. We study the organization of grazing during the summer stay of sheep and its repercussions on the spatial distribution and the use of different types vegetation by the chamois. Having into account their influence on the use of the pastureland by the chamois, a special attention is paid to the location of sheepfolds and to the length and shape of the daily courses of the flock.

1. The Study Area

The study was carried out in a 750 ha. pastureland —a common property "puerto"— in the Cantabrian range (Lois, León province, northern Spain). It was traditionally used to rear transhumant merino sheep in summer. Most of the area ranges from 1200m to 1700m of elevation and very little is above 1700m. It is predominantly northern oriented, being the eastern oriented slopes very escarce. Lithological substratum is mainly calcareous (80%) and made of erosion-proof materials that has originate the steep and rough areas. Vegetation consist of of herbaceous pasture with variable proportions

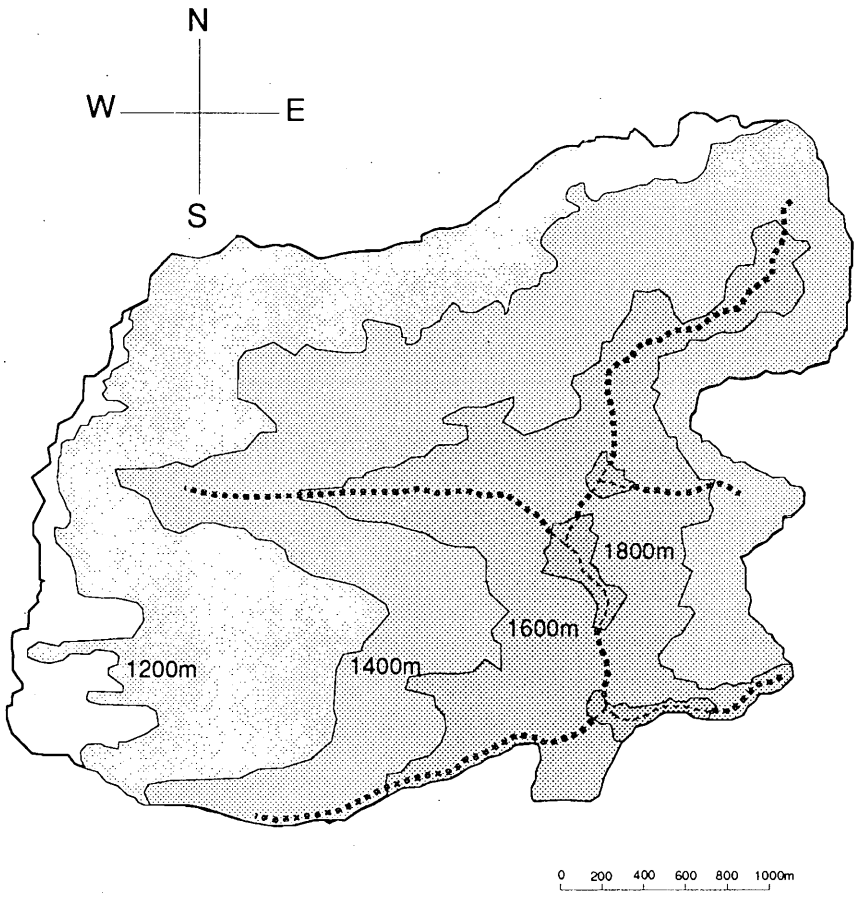

Fig. 1. Study Area. Thin lines indicate contour lines and dotted lines represent ridges. *(Area de estudio. Las líneas continuas indican las curvas de nivel y las líneas discontinuas las crestas).*

of scrub (*Calluna vulgaris, Genista hispanica, Juniperus communis*). Beech woods are abundant in northern oriented slopes. At lower altitudes there is a small number of private property fields dedicated to meadowland.

The flock of 1.050 sheep remained in the study area from the mid June to the mid October. Chamois —over 40 individuals— remained in the area throughout the year but were sampled between May and October. The lower areas are kept for cattle (22 individuals) until the end of July when sheep begin to graze on them.

2. Material and methods

Sampling of herbivores land-use was carried out in 1990. Location of the sheep flock and chamois population was made on a sectorized map based on geological and vegetation types, altitude and orientation. This cartography was elaborated from aerial photographs with the help of thematic maps and direct field survey. Habitat variables were obtained from regular sampling over a grid of 396 points —with 150 m. actual distance between points— on the thematic maps and aerial photographs. At each point, elevation (seven levels), orientation (four classes) and vegetation types (six classes) were sampled. Grazing organization was studied by means of enquiries to the shepherds aimed to know the concrete course of the daily flock displacements during the whole period of the stay in the high pass. Direct track of the courses were made two days per month. The presence of sheep were noted down for each node of the grid. Spatial distribution and land use by chamois was sampled by means of fixed itineraries enabling complete visual control of the whole area (GARCÍA-GONZÁLEZ, 1985). Chamois sampling took place in May before the arrival of the sheep flocks and continued at monthly intervals during the summer stay period. Chamois activities were noted systematically in each sampling as well as habitat variables of the locations of the groups in maps at 1: 10.000 scale.

Due to the different kind of data available for each species , corrected frequencies (GODRON, 1968) and profile index (GAUTHIER *et al.*, 1977) were used to analyze sheep habitat selection and preference indexes (HUNTER 1962, PRATT *et al.*, 1986) to assess land use by chamois. Corrected frecuency for each class of a variable vj were calculated from the data sampled on the grid arrangement as follows:

$$CF = (vij/ni)/(V/N)$$

N= number of points (nods) of the grid covering the whole area.
ni= Points corresponding to sector i.
V= Points of the whole area where the variable vj is present.
vij= Points of the sector i where the variable vj is present.

The statistical significance of CF was tested from the 2 x 2 contingency table by means of profil index.

Preference index was made to assess the habitat selection by chamois according to the formula:

$$PI=(ci/C)/(V/N)$$

C= Number of individuals of chamois seen in the whole area.
ci= Number of individuals in the points where vj is present.

3. Results

3.1. *Components of the pastoral system which are important in the organization of sheep activity*

Sheepfolds, resting areas, salt-licks, tracks and water supply points (Fig. 2) are components of the pastoral system that influence the organization of sheep activity.

The sheepfolds —shelter, enclosures and associated pastures where the flock spend the night— as well as the cabin used by the shepherd, are situated in a strategic location aimed to facilitate a suitable use of the pastureland. This position come from a compromise between several factors: water supply, accesibility, nearnees to the pastures, etc. The whole sheepfold has a considerable importance in the management of the pastoral system and therefore is perceived by the shepherds as a unit called "majada". From sheepfolds, daily courses are normally made towards higher altitudes being their length limited by the necessity of returning at night. In order to take advantage of the whole rangeland production, four sheepfold changes were needed in the studied case.

The salt-licks (where salt is supplied to the livestock) are always located near the sheepfold and can be considered as a part of the whole of components that make up it. Salt is brought to the livestock every week.

A network of tracks across the pasture, connecting sites of main interest in the rangeland is used by the flock for the displacements, specially when it moves forming files.

Supplying water simultaneously for the whole flock is only possible in the main stream of the pastureland, always below the 1500 m. level and at similar or inferior altitudes than the sheepfold. This location difficults a longer stay of the flock at the summits and ridges, and forces the animals to descend to water at nigthfall.

The resting areas are the places usually used by the animals at noon, during the hottest part of the day. On the courses towards areas situated below the sheepfolds, resting places were located in shady sites at the edge of beech woods, or on fresh and windy places in the slopes. The courses going above the sheepfold, the animals rested in areas near to the ridges, especially close to mountain passes.

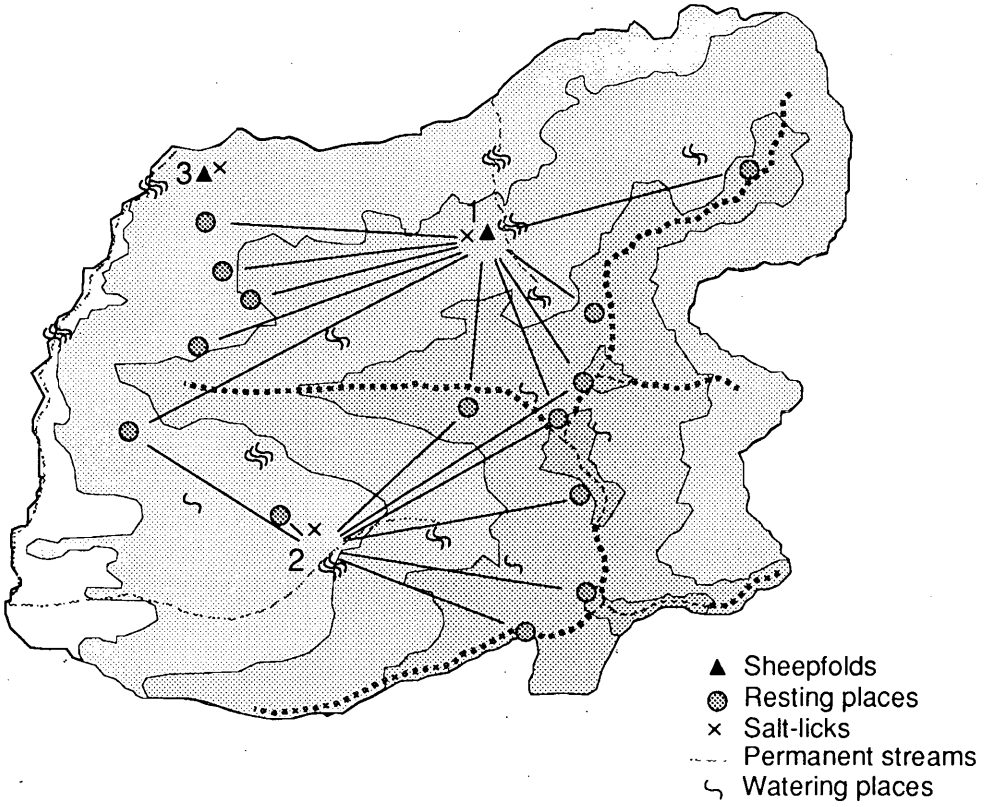

Fig. 2. Components of the pastoral system which are important in organizing sheep activity. Straight lines represent the relationships between the sheepfolds and resting places. Flock does not use resting places from the sheepfold 3 occupied in October. The location of the resting places close to ridges allows to make good use of the east oriented pastures, the first shaded in the afternoon. In watering places, one symbol indicates water available for few animals, two for small groups, less of 50 animals, and three means the whole flock may drink there. *(Elementos del sistema pastoral con importancia en la organización de la actividad de las ovejas. Las líneas rectas representan las relaciones entre las majadas y los sesteaderos. El rebaño no utiliza sesteaderos desde la majada 3, ocupada en octubre. La localización de los sesteaderos en la proximidad de las crestas facilita el aprovechamiento de los pastos orientados al Este, los primeros que tienen sombra por la tarde. En los abrevaderos, un símbolo indica agua disponible para pocos animales, dos para grupos menores de 50 individuos y tres que todo el rebaño puede beber).*

3.2. *Land use by herbivores*

For sheep activity we distinguish four grazing periods (Fig. 3). The area grazed in each one depends on the sheepfold location (1, 2 and 3; Fig. 2). In

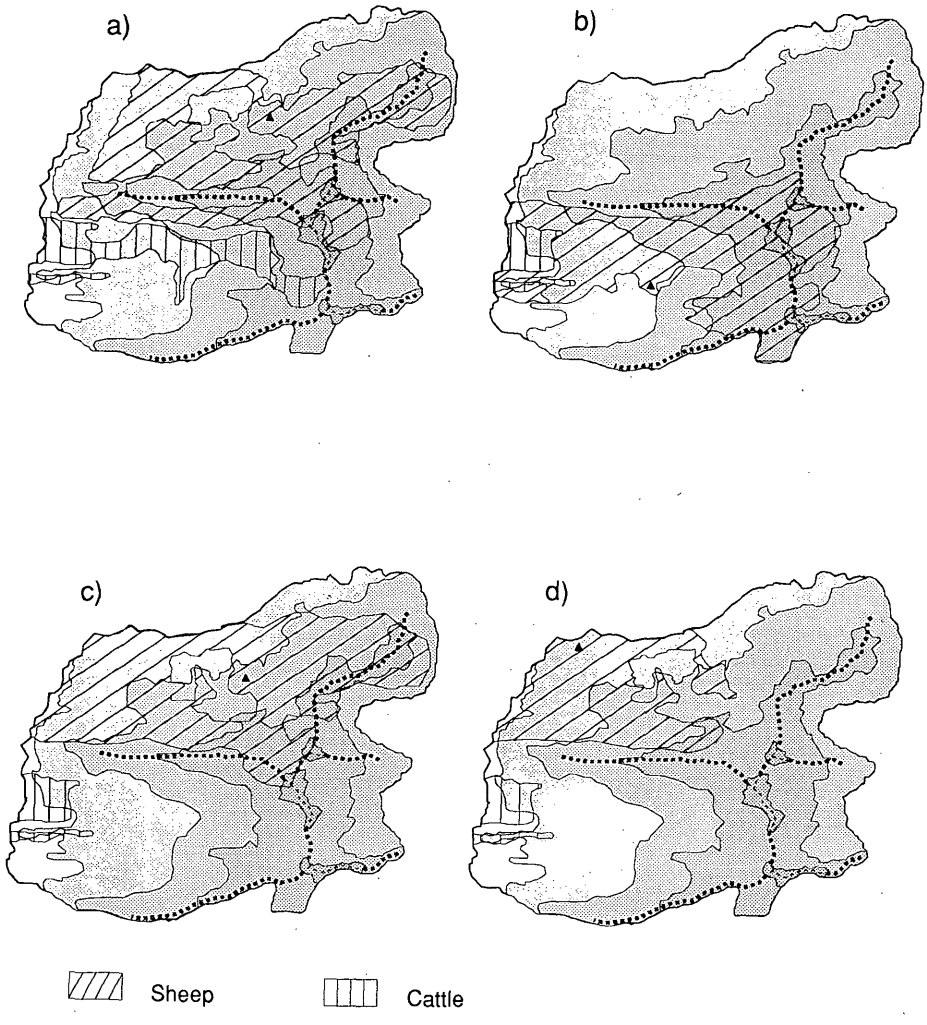

Fig. 3. Ranging areas of sheep and cattle during their summer stay in the pastureland. The black triangle indicates the position of the sheepfolds in each period; a) June-July, b) August, c) September and d) October. *(Areas de campeo de ovejas y vacas durante su estancia estival en los puertos. El triángulo negro indica la posición de las majadas en cada periodo; a) Junio-Julio, b) Agosto, c) Septiembre y d) Octubre).*

the case of chamois (Fig. 4) there is a clear difference in the situation of the groups before and during the sheep's grazing period. During May, before the arrival of sheep, 63% of the observed chamois graze on areas later used by sheep. After the arrival, these groups have been reduced to 24% and always at the outer edges of the area ranged by the flock. The contact zone between the two species is a continous strip coincident in a large extent with the ridges. The overlapping area is very small and most of it is placed on the slope used by chamois. The position of the chamois did not vary during the sheep stay and the contact area remained the same independently of the sheepfold utilized. In October sheep occupied the lower altitude sheepfold where they spent the last fifteen days of their summer stay in the high pass.

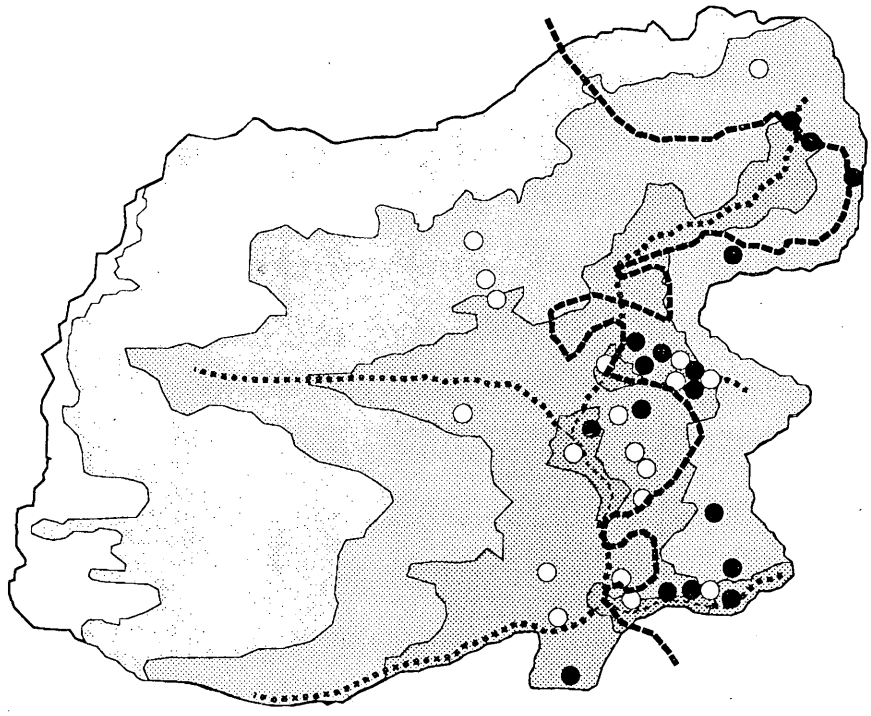

Fig. 4. Location of chamois groups before the arrival —white circle— and during the summer stay —black circle— of sheep. The darkest line represent the limit of the sheep range area. *(Situación de los grupos de rebecos antes de la llegada de las ovejas —círculo blanco— y durante la estancia estival —círculo negro— de las mismas. La línea más gruesa representa el límite del área de campeo de las ovejas).*

We do not have exact data on the position of the chamois for this period, although it would seem that this is the moment they begin to move back into the land left by the flock.

3.3. *Influence of the elevation*

Table I shows that sheep have few preference for a specific range of elevation in June, July and September. However, in august they favour areas above 1600 m. and use significantly less the intermediate areas (1.400-1.600 m.). The exploitation of higher altitude pastures begins late, when the grass has fully grown and with very long courses that enable a very short time for the livestock graze on each concrete pasture community. In October the lower areas—below 1.400 m.—are used; those above 1.500 m. are significantly rejected and those above 1.700 m. are completly abandoned. The flock moves to the lower sheepfold —about 1.000 m.— due to the worsening of weather at higher altitudes and to the fact that the pastures have been already grazed very intensively above 1.400 m. From this position the livestock take better advantage of the late resprouting pasture grazing with preference between 1.200 m. and 1.400 m.

Chamois were always situated at heights over 1400m. Before the arrival of sheep they favoured altitudes of over 1.600 m.; later a slight descent may be noticed, situating them between 1.500 and 1.600 m. but in the slope of the opposite aspect.

3.4. *Orientation types*

In June-July no significant preferences were noted (Table I). In August southern and western orientations were favoured to the detriment of eastern and northern. Actually grazing of south oriented slopes —sunny areas— is begun with a noticeable delay when pasture is dry. In June and July sunny areas were slightly grazed due to the long courses the flock has to make on rough zones where is difficult to accede. This cause an excess of grazing in north oriented zones at this time. From early September there is a decrease of grazing in south oriented slopes and an increase in the north oriented ones where grass is fresher. East oriented slopes are completely deserted as they are more distant from the sheepfolds.

Before the sheep arrival, chamois prefer northern, western or eastern orientations. During the sheep stay, chamois abandone east-oriented slopes and concentrate on shaded areas of the northern aspects.

TABLE 1

Corrected frequencies with profile index for sheep and preference indexes for chamois, according to elevation, aspect and vegetation classes. In order to assess the relationships between land use and habitat variables, four periods were considered for sheep and two for chamois (A before and B during the sheep stay). For corrected frequency and preference index, the values lower and higher than 1 indicate, respectively, rejection and preference for the class of the variable. In profile index, "+ + + o - - -", "+ + o - -" and "+ o -" indicate signification of 99%, 95% and 90% respectively. *(Frecuencias corregidas y su perfil índice para las ovejas e índices de preferencia para los rebecos, según niveles altitudinales, tipos de orientación y clases de vegetación. Para valorar las relaciones entre el uso del territorio y las variables del hábitat se han distinguido cuatro periodos para las ovejas y dos para los rebecos (A, antes y B, durante la estancia de las ovejas). En la frecuencia corregida y en el índice de preferencia, los valores más bajos y más altos de 1 indican rechazo y preferencia respectivamente. En el perfil índice, "+ + + ó - - -", "+ + ó - - " y "+ ó -" indican significaciones del 99%, 95% y 90% respectivamente).*

	SHEEP				CHAMOIS	
	June-July	August	September	October	A	B
< 1200m	.24 (--)	.85 ( )	.48 ( )	.88 ( )	.00	.00
1200-1300m	1.02 ( )	.88 ( )	1.39 (+)	2.52 (+++)	.00	.00
1300-1400m	1.03 ( )	.87 ( )	.94 ( )	1.50 (+)	.00	.00
1400-1500m	.83 ( )	.57 (--)	.93 ( )	1.09 ( )	.09	.37
1500-1600m	1.29 (+)	.50 (--)	1.28 (+)	.54 (-)	.78	1.07
1600-1700m	1.14 ( )	1.45 (+)	.92 ( )	.20 (--)	1.55	1.81
> 1800m	1.04 ( )	2.70 (+++)	.72 ( )	.00 (---)	6.45	4.94
North	1.06 ( )	.51 (---)	1.21 (++)	1.30 (++)	1.00	1.99
South	1.10 ( )	1.75 (+++)	.60 (--)	.60 (-)	.18	.17
East	.95 ( )	.55 (-)	.94 ( )	.49 (-)	1.61	.00
West	.81 ( )	1.42 (++)	1.04 ( )	1.07 ( )	1.31	.78
Beech wood	.20 (---)	.30 (---)	.66 (--)	.26 (---)	.07	.00
Past. with furze	1.48 (++)	2.22 (+++)	.89 ( )	1.20 ( )	.20	.58
Rocky zones	.67 (-)	.42 (---)	.36 (---)	.16 (---)	2.38	5.19
Past. with junip.	1.42 ( )	1.65 (+)	1.41 ( )	.18 (---)	4.22	.16
Meadows	.00 (---)	1.61 ( )	.00 (---)	.00 (---)	.00	.00
Other pastures	1.83 (+++)	.84 ( )	2.05 (+++)	2.78 (+++)	.89	.00

3.5. *Vegetation types*

Sheep avoid beech woods, rocky areas, crags and screes and favour herbaceous vegetation (Table I). Areas of pasture with furze (*Genista*

hispanica) are favoured in June-July and August. Private plots are only grazed in August. Pastures with juniper (*Juniperus communis*) are favoured in August. In October the higher altitude pastures as well as those at the edges and in the clearings of beech woods are abandoned. Activity is concentrated in areas of nitrophyllous pastures. These areas where the late resprouting is greater due to the accumulation of manure, are generally situated close to the site of former sheepfolds. Autumn activity also concentrates on pastures of siliceous soils —especially at shaded areas— which retain moisture to a greater extent than those on limestone soils.

Before the sheep's arrival, chamois concentrate their activity on high altitude pastures (with juniper), on rocky and steep slopes with some scattered herbage. Afterwards, they move to more inaccessible areas and slightly increase their presence in pastures with furze —*Genista hispanica* scrub—.

4. Discussion

Unlike the summer pastures of the Pyrenees, where the large size of the pastureland include a wide range of altitudes (GARCÍA-GONZÁLEZ *et al.*, 1990), the southern side of the Cantabrian range, has scarce presence of pasturelands larger than 500 ha (GÓMEZ-SAL *et al.*, 1990). The dominant ridges are in these mountains rarely over 2000 m of altitude. In the Cantabrian range an elevational segregation among ungulates as remarkable as those observed in the Pyrenees does not take place. Sheep grazing reaches all heights and only avoids beech woods, steep rocky slopes and dense scrub. Beechwood has no herbaceous layer and only its edges are used as resting places searched for shade in July and August. Steep rocky areas are avoided by shepherds because of the risk of livestock losses or injuries. Finally when the scrub cover is thick the animals find difficulties to move across. Chamois do not choose higher altitude areas but rather look for rocky places which are not used by sheep (i.e. BERDUCOU, 1988). As the area ranged by sheep depends on the distance from the sheepfold, allowing movement forward and backward, chamois occupy the edges of the area covered by sheep courses and staying furthest away from the sheepfolds. In the zones where sheep grazing pressure is high the effect of other factors on the habitat selection by chamois such as the phenological wave of pasture production (ANDERSON and SCHERZINGER, 1975; GARCÍA-GONZÁLEZ *et al.*, 1985; GARCÍA-GONZÁLEZ *et al.*, 1990), hunting (BERDUCOU, 1984; GARCÍA-GONZÁLEZ, 1985) or visitors (BERDUCOU, 1984; GARCÍA-GONZÁLEZ, 1985; HAMR, 1985) is hindered. In contrast to what happens on pasturelands having a large range of altitudes, the Pyrenees for instance, segregation between ungulates in Cantabrian pastures seems to occur horizontally, taking advantage of the differences between facies in the pastoral ecosystem with regard to shelter —hidden areas—, production and accessibility.

Chamois selected rocky areas with scattered pasture, in north oriented slopes where it found a suitable combination of shelter and food (ELSNER-SCHACK, 1985). This location on northern aspects coincides with what has been observed by most authors dealing with the summer land use (WILLMS *et al.*, 1979; ELSNER-SCHACK, 1985; GARCÍA-GONZÁLEZ, 1985). The chamois remained in these areas through the whole summer, also coinciding with the observed in other areas (HAMR, 1985), and seemed to be somewhat unaffected by changes of sheep ranging area. Only a few sorties into sheep area were observed but not long incursions to salt-licks, as were noted by other authors (GARCÍA-GONZÁLEZ, 1985, among others).

Sheep grazing followed in broad outline the phenological wave of pasture production (GARCÍA-GONZÁLEZ *et al.*, 1990) in close relation to altitude, aspect and the manuring left from previous years. However, as sheep must make their diary courses from sheepfolds, the management of the pastoral system is limited by the distance, number and location of the sheepfolds, and also by the possibilities of changing from one to another at certain times during the summer (GÓMEZ-SAL *et al.*, 1991). In the studied case this changes are conditioned until the end of July, by the rights of the cow raisers, which allow cows to graze on the plots that were formerly hay meadows, placed at the flatter and more productive ground of the bottom of the valley. This fact prevents during this time the use of the sheephold that will allow to take advantage of south oriented slopes in this zone. For this reason the use of the sunny south faced aspects in June as well as the higher zones in the southern sector, did not take place at the time when these areas reached their maximum productivity. That also explain why the use of higher altitude areas was delayed in July. In the studied pastureland the inapropiate low position of the sheepfolds, making it necessary for long daily courses and so implying quick ranging on the pastures, hindered the suitable use of high altitude production. This situation seems to favour the use of this part of the pastureland by chamois.

5. Conclusions

—The interaction between wild and domestic ungulates seems to be based on the intolerance of chamois towards flocks of domestic sheep. It has not been possible to prove that this is due to the presence of shepherds and dogs, but the chamois seem to ignore the area progressively left by the sheep. It merely places its summer area where the flocks cannot reach.

—The number and location of folds, and the changes from one to another, determine the sheep land use and limit the presence of chamois in zones of heavy pastoral pressure. Chamois occupy steep rocky areas which are not grazed by sheep and which are situated far from the folds. In the studied case sheepfolds are placed at a fairly below altitude. This is due to the necessity of not being far away from water supply, but avoids a suitable use of the high zones of the pasture.

—The land use by sheep follows the phenological wave of pasture production, although two peculiarities should be mentioned:

a) Land use is controlled by the shepherds who lead their flock to zones of the range which they previously knows, but once the type of course has been chosen the flock has a relatively wide margin for the definitive shaping of it.

b) The use of the rangeland is greatly affected by the components of the pastoral system, built by men or originated by animal behavior in previous times and which constitute the heritage that enables and facilitates the best exploitation of the rangeland. These components may include also ancient rules which regulate the use of the pastures which in some cases, such as the rights for cattle to use the lower pastures, may act against the rational management of sheep farming.

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